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WORKERS' PERCEPTIONS OF SAFETY AS A PREDICTOR OF INJURY.(U)
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Workers' Perceptions of Safety as a Predictor of Injury*

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Safety Perceptions

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Safety Perceptions

Workers' Perceptions of Safety as a Predictor of Injury*

Abstract

Perceptions of work area safety by enlisted personnel aboard 20 U.S. Navy ships were analyzed in terms of sources or components of the perceptions and the effectiveness of these components in predicting subsequent injuries. This analysis showed that perceptions of safety reflected actual differences among situations which were related to differences in physical environment, work and social environment, and personnel resources. Differences among individuals' perceptions within the same situations could be partially accounted for by individual background data. The portion of individuals' perceptions which reflected situational differences could be scored and used as an effective predictor of injury rate. An even more effective predictor was a score that reflected only the situational variance explained by the physical environment, the work and social environment, and the personnel resources. The results indicate that work situations can be assessed and scored as to degree of hazard present, making possible remedial actions prior to the occurrence of injuries.

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Workers' Perceptions of Safety as a Predictor of Injury*

Although industrial accidents are enormously costly in terms of economic loss, human suffering, and other factors, research aimed at identifying causes of accidents has been somewhat inconclusive (cf. Surry, 1974). One major problem in such research has been the difficulty in clearly defining what constitutes an accident. For example, Suchman (1961) noted that accidents have been described in terms of their predisposing conditions or situational antecedents, the conditions of their occurrence, and their outcomes or effects. Suchman concluded that, from the viewpoint of preventing accidents, attention should be focused on the conditions of occurrence, noting that these conditions could be rated in terms of their degree of unpredictability or unexpectedness, degree of unavailability, and the degree to which they were unintentional.

From a somewhat more pragmatic perspective, Gibson (1961) argued that research aimed at the prevention of injury or damage makes sense only to the extent that one studies events which are preventable but not avoided as opposed to events defined as unpredictable and, hence, uncontrollable. Since the term accident traditionally includes both unavailability and unpredictable events, Gibson felt the concept should be discarded by researchers and that attention should be focused on the signs of danger or "external sources of potential injury" within the environment.

The present authors suggest that accident defined as an unpredictable or unexpected event remains a useful concept and that such a definition does

not necessarily imply that accidents are entirely uncontrollable. That is, accidents may be unpredictable because of uncertainty regarding the time of occurrence, but certain circumstances are more likely than others to consistently manifest the sequence of unexpected or aberrant events normally referred to as accidents. Therefore, to the extent that the likelihood of an accident is greater in some circumstances than others, considerable predictive and explanatory information may exist.

In this regard, Suchman (1961) suggested the importance of measuring the degree to which events are unexpected and determining the consequences of each event in terms of injury and damage. Gibson (1961) argued that injuries result when individuals go unprepared into situations containing a potential for harm. Thus, a hazardous environment would be a situation in which an accident was likely to occur and which contained the potential for inducing injury or damage. However, Gibson (1961) noted that in a given situation individuals may differ in their ability to perceive the signs of danger, so that within any situation the expected outcome will differ among individuals.

To account for individual differences, it has been suggested that individuals form cognitive maps of the environmental situation which guide their behavior in that setting (Ittelson, Proshansky, Rivlin, & Winkel, 1975). In this sense, constructs such as safety represent a cognitive integration of many aspects of the environment. Thus, both the external sources of potential injury and the context in which they occur are important in determining

the amount of danger an individual perceives in a particular setting. The individual's perception of danger also appears to reflect a comparison between perceptions of the existing situation and an underlying personal construct or concept of safety. For example, Gibson (1961) noted that individuals who were overprotected as children often failed to perceive situational signs of danger. Thus, persons with limited experience would likely have less enriched constructs of safety and their comparisons of given situations with such constructs would be different and less informative than persons with a wider range of experience.

Based on the above points, it would appear of major importance for research concerned with accidents and/or safety to incorporate a methodology which allows the researcher to explore the external characteristics of the situation in combination with those individual attributes which are most salient in determining perceptions of safety. In the present study, a method developed by Pugh (in press) was employed to accomplish this goal. The method determines the relative influences of the situation and of individual characteristics upon both perceived safety and injury rates.

Method

Subjects

Subjects were male, enlisted personnel aboard 20 U.S. Navy combat ships, including three destroyers, six guided missile destroyers, three frigates, six destroyer escorts, and two aircraft carriers. The crew sizes of these ships ranged from 225 men to 375 men, except for the aircraft carriers which had complements of approximately 3,000 to 4,000 men. Each ship

was organized into four or more departments, with each department responsible for a major set of duties such as weapons, engineering, operations, and supply. Departments were further divided into divisions which were assigned more specific tasks. For example, the Engineering Department consisted of divisions concerned with the boilers (B Division), the engines (M Division), and so forth.

Questionnaires were administered to crew members near the beginning of a 6- to 8-month deployment period. For destroyer-type ships, approximately 70% of each ship's crew responded to the questionnaire. Aboard the aircraft carriers, personnel in aviation divisions were excluded from the test program and a stratified sample of the remaining divisions was tested. In this way approximately 10% of each aircraft carrier crew was tested (or approximately 45% of the sampled divisions).

Inclusion of an individual crew member in the study required a properly completed questionnaire, work group location data, completed ratings of the individual's division, and individual illness data for the entire cruise period. A total of 2,305 sailors met these requirements. This group was then separated into an analysis sample ($n = 1,147$) and a cross-validation sample ($n = 1,158$). The samples were balanced with respect to ship assignment, department membership, and pay grade (occupational level); assignment to analysis and cross-validation groups was otherwise arbitrary.

Instruments

Ratings of shipboard living and working conditions were obtained by

means of a 400-item Habitability and Shipboard Climate Questionnaire designed to assess physical, social, and work environments aboard ship (cf. Jones & James, Note 1). The selection of specific items for inclusion in the present study is described below.

Division officers completed a set of ratings which described division performance (Jones & James, Note 1). These ratings addressed eight areas of division performance--quality of work, completion of planned maintenance schedules, readiness to fulfill commitments, performance under pressure, efficiency of performance, cooperation with other divisions, safety, and quality of leadership. These ratings were obtained at the end of the ship's deployment. Ratings also were obtained of the resources available to the division in terms of the quality of equipment and the quality of men assigned. These ratings were obtained at the beginning of the deployment.

Injury data were obtained from the ships' medical departments. Check-list forms provided by the researchers were filled out by the hospital corpsmen for each dispensary visit. Information regarding illness type, date of visit, and number of days lost from duty due to disability were entered on the checklist. These records were subsequently utilized to compute morbidity rates. All data collection instruments used in this study have been described in detail by Jones and James (Note 1) and La Rocco, Gunderson, Dean, James, Jones, and Sells (Note 2).

Procedure

Work area safety was assessed by a questionnaire item requesting each

man to rate his work area on a 5-point scale ranging from a low score for "hazardous" to a high score for "safe." Previous reviews of research in the area of safety and accident prevention (Gibson, 1961; Suchman, 1961; Surry, 1974) suggested four possible sources of the perception of safety. In the present study the following variable domains were delineated to represent those sources: (1) the physical environment, particularly the condition of work equipment; (2) work and social environment, including how well abilities were matched to tasks performed, work supervision and regulation, and relationships among co-workers; (3) personnel resources, that is, the overall quality and experience of the work group; and (4) individual differences, that is, unique background characteristics and abilities not necessarily known to the work supervisor which may qualify or disqualify a man to perform a particular task.

Specific variables were selected to represent each of the above domains. For example, the work and social environment domain was assessed by 23 items from the questionnaire. These items were drawn from 35 homogeneous a priori organizational climate composites (cf. Jones & James, Note 1). The decision to use items rather than composites reflected a desire to tie the construct of safety to concrete or specific aspects of the environment rather than to more abstract dimensions.

Ratings of the environment by individual crewmen were converted to a set of situational scores, called here area characteristics, by computing mean values for each work area on each variable. Thus, the mean values for the perceptions of work area safety were the area characteristics of safety.

Additionally, the differences in perceptions of safety among individuals within areas was scored by computing differences between individuals' raw scores and area characteristics of safety. This score was called individual uniqueness.

In order to explain or delineate the variance of work area safety, predictor variables within each of the four domains were regressed against the individual ratings of safety in the analysis sample. The regression weights from each of the analyses were applied to the data for every individual in the analysis sample to generate a prediction from each domain--physical environment, work and social environment, personnel resources, and individual differences. These predicted scores represented four components of the judgments of safety which could be empirically related to other environmental or background measures. A final regression analysis was employed to combine the three situational scores--physical environment, work and social environment, and personnel resources--to create a delineated situation safety score, that is, the total variance empirically related to identified aspects of the environment.

The possibility that there were some important but unidentified situational sources of safety perceptions was addressed by computing area characteristic scores (mean environmental ratings) and subtracting the delineated situation safety scores from the area characteristic scores, leaving the unexplained situational variance, or residual situation component of safety. Similarly, individual uniqueness was separated into delineated individual

differences, which was the predicted score generated by regressing background variables against the ratings of safety, and the residual individual differences component, which was developed by subtracting all of the variance accounted for by the area characteristic score and the delineated individual differences from each subject's raw rating. Components of the perception of safety and their relationships to each other are shown in Figure 1. The above methods have been previously discussed in detail by Pugh (in press).

Insert Figure 1 about here

After the components of work area safety described above were derived from the analysis sample and these procedures were evaluated in the cross-validation sample, the component scores were used as predictors of injury rates. These injury scores were expressed as the number of injury cases for that individual corrected for the number of days of exposure. Cases included all initial visits to the dispensary for any bodily injury or for musculoskeletal complaints since these latter disorders were usually the result of trauma. In addition, a noninjury morbidity rate (based on all other illnesses) was computed in a similar manner for each man.

Results

Analysis of the Sources of Safety Perceptions

Items were grouped into their respective domains, and each set (domain) of items was regressed separately against individual judgments of work area safety. A stepwise procedure was used to delete variables with little or no unique contribution to the prediction of the safety judgments. Items

retained in each regression equation are shown in Table 1. Thus, items were often deleted by the stepwise procedure not because of their lack of validity but because of their redundancy with respect to previously included items.¹ However, a sufficient number of items remained in each equation so that a reasonable degree of stability for the predicted scores could be expected. It is noted that many of these predictors were area characteristics (mean ratings) of other environmental dimensions. Inspection of the correlations of the predictors with individual judgments of work area safety indicated that areas were perceived as more dangerous where equipment was judged to be unreliable and in need of repair, where men reported that their abilities were not matched to their jobs, where they felt that they were not qualified to perform required tasks, where it was felt that work methods were not up-to-date, where work was not "done by the book," and where the men were relatively young and judged by division officers to be inexperienced. Additionally, men with prior histories of school adjustment problems tended to view their job environments as more dangerous than men without such histories.

Insert Table 1 about here

The multiple correlation of each regression equation with judgments of safety for the analysis sample, and the cross-validation coefficients for these equations, are shown in Table 2. All of the correlations in this table were significant ($p < .01$) and three of the equations appeared to be stable--those for physical environment, work and social environment, and individual differences. The fourth equation--personal resources--had a much lower

correlation in the cross-validation sample than in the analysis sample.

Insert Table 2 about here

In addition to the above predictors, each subject was scored on the difference between the area characteristic score (mean rating of safety) and the delineated situation score (predictable situation) in order to determine the degree to which situation effects were not accounted for by the environmental measures (physical environment, work and social environment, and personnel resources). This score, the residual situation component, accounted for slightly more than 10% of the variance of individual judgments of safety.

Prediction of Illness Rates

With the several components of the perception of safety isolated and scored, the final step in these analyses was to evaluate safety as a predictor of injury and, in contrast, as a predictor of noninjury morbidity. The results of this analysis are shown in Table 3. The correlations of the raw judgments of safety with the illness criteria appeared rather unstable and difficult to interpret. However, inspection of the correlations of separate components of safety, that is, items combined with weights to generate optimal predictions of safety, indicated consistent but low correlations between situational components and injury rates. For instance, the area characteristic score and injury rate correlated $-.13$ and $-.12$ in the analysis and cross-validation samples, respectively. In other words, those areas which were perceived to be more hazardous tended to have higher injury rates.

Further, the delineated situation scores were also related to the injury criterion. The delineated situation score, which combined physical environment, work and social environment, and personnel resources, correlated $-.20$ with injury rate for both samples. Comparing the separate correlations of physical environment, work and social environment, and personnel resources with injury rate to the correlation between delineated situation and injury rate indicated considerable redundancy in the portion of the injury rate variance accounted for by each component of the delineated situation. The residual situation component was not significantly correlated with the injury criterion.

Insert Table 3 about here

The correlations of safety with rate of noninjury illnesses showed that only the situational sources of safety were related to the criterion. This corresponds to the results for the injury criterion. However, the correlations with noninjury illnesses tended to be lower and less stable than the comparable correlations with injury, which support the proposition that perceptions of safety specifically predicted injuries.

Discussion

It was suggested earlier than a strict definition of accidents as unpredictable events is somewhat misleading because certain combinations of situations and persons are more or less likely than other combinations to lead to the event-injury risk sequence normally referred to as accident. The

empirical investigation of various person-situation combinations and their associated probabilities of accident occurrence thus provides a basis for accident prediction and, hopefully, for more effective programs of accident prevention.

The present study used mean individual perceptions as an index of situational safety (i.e., an area characteristic) and found that these area characteristic scores were significant predictors of individual injuries. In other words, individuals working in areas with higher safety scores tended to have fewer injuries. A further, though slight, improvement in the prediction of accident-related injury was obtained with the use of delineated situation scores which reflected the portion of the area characteristic (or mean perceived safety) score that was predictable from other obtained situational measures. Such findings are noteworthy not only because they indicate that unsafe conditions can be identified and corrected before costly injuries occur, but more importantly because they suggest that area safety and the ensuing risk of accidental injury reflect a variety of environmental factors. Based on these results, it appears that accident research and prevention programs must consider a variety of social and personnel factors such as work group supervision and coordination, and personnel utilization, training, and experience in addition to physical parameters such as condition and quality of equipment.

These findings would appear of special importance for future research, with their implications that management controlled variables such as super-

vision style, training, and personnel assignment may be of equal importance to equipment-related hazards in predicting and controlling accidental injury. Pursuant to such logic and insofar as certain jobs, especially aboard ship, inherently involve the operation of hazardous equipment, it would appear highly productive to explore the possibility that certain leadership styles and management policies are more appropriate for high risk environments. It would also appear important to consider such issues relative to different levels of personnel training, experience, and ability. For example, one can readily understand the potential importance of such factors in the case of left-handed persons using equipment designed for right-handed individuals. Such a circumstance might well represent a higher degree of hazard for the left-handed employee than for his right-handed co-workers.

In light of the foregoing emphasis and the recent attention to the interactionist perspective (cf. Bowers, 1973; Ekehammar, 1974; Endler & Hunt, 1966; Engler & Magnusson, 1976), some comment appears warranted regarding the findings of the present study, where individual measures did not appear to be significantly related to injury. It is likely that these results at least partly reflected certain methodological aspects of the study. In the first place, the major index of individual differences was the individual uniqueness score, which reflected the difference between each person's perception of area safety and the norm for others in the same situation. This score represented actual differences in the amount of hazard experienced by individuals in the same work area as well as the influences of a variety of

individual variables upon perceptions of safety. Second, direct measures of individual characteristics such as age, rate, pay grade, mechanical aptitude, and so forth were either not included in the present study, or were included in mean form in the personnel resources equation. Thus, the study did not represent a fair assessment of the role of individual differences. Such assessment must await future research directed more explicitly toward the exploration of relationships and interactions between the physical and social aspects of the work environment on the one hand, and individual characteristics, needs, and abilities on the other, especially as such interactions affect accidents and injury rates.

In a related vein, the somewhat surprising relationship between area safety and the incidence of noninjury illnesses is also of interest. Such a relationship is not illogical insofar as hazardous conditions may represent a set of general environmental stressors and thus be associated with increases in a variety of illnesses (cf. Rahe & Arthur, 1968). In addition, many of the predictors of injury might also be expected to be involved in the etiology of other disorders. For example, two of the items which were significantly related to injury in the present study--age and education--have also been found to be significant predictors of total illness in other Navy samples (Gunderson, Rahe, & Arthur, 1970). Thus, to the extent that conditions related to high injury rates also covary with other illnesses, similar levels of prediction would be expected.

In conclusion, the present study suggested that not only are accidents

and accident-related injuries predictable, but they reflect aspects of the work environment beyond the commonly considered aspects of equipment hazard. Future analyses and studies of accidents, therefore, should further address the influences and interactions of such factors as equipment hazard, management and leadership characteristics, as well as various individual level measures such as ability, experience, and training.

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Footnotes

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¹Many of the items had been constructed initially to represent a priori constructs. Thus, considerable conceptual and empirical overlap existed.

Table 1
Correlations of Items from Four Domains with
Perceived Work Area Safety^a

I. <u>Physical Environment</u>	<u>r</u>
Quality of work equipment ^b	.27
Ability to obtain funds for supplies ^b	.23
Lack of crowding ^b	.18
Officers' evaluations of work equipment ^c	.26
II. <u>Work and Social Environment</u> ^b	
Abilities are not matched to job	-.27
Complete "a whole piece of work"	.15
Suggestions are paid attention to	.16
Work methods not kept up-to-date	-.25
Rigid standards of quality are not met	-.20
Work is not "done by the book"	-.19
Work load induces strain on crew	-.15
Not fully qualified for task performed	-.17
III. <u>Personnel Resources</u>	
Have enough men to perform job ^b	.16
Amount of crew experience ^c	.18
Crew performs tasks in a safe manner ^c	.10
Mean age (per division)	.22
Mean years of education (per division)	.21

^aAnalysis sample, including some subjects with no illness data ($n = 1,377$).

^bMean ratings by division (work area) members.

^cRatings of divisions by division officers.

Safety Perceptions

20

Table 1 (continued)

IV. <u>Individual Differences</u>	r
Performance marks seen as unimportant	-.10
Parents were often called to discuss school problems	-.10
Rarely tardy in last year of school	.11

Table 2
Correlations between Four Variable Domains and
Work Area Safety for Analysis and Cross-Validation Samples

<u>Equation</u>	<u>Analysis</u>	<u>Cross- Validation</u>
Physical environment	.30 ^a	.30
Work and social environment	.34	.28
Personnel resources	.30	.19
Delineated individual differences	.13	.14
	N 1,147	1,158

^aCorrelations for the analysis sample are multiple correlations;
the specific items are indicated in Table 1.

Table 3

Correlations of Perceived Work Area Safety and Its Components with Illness Criteria

<u>Predictor</u>	<u>Injury</u>		<u>Noninjury</u>	
	<u>Analysis</u>	<u>Cross- Validation</u>	<u>Analysis</u>	<u>Cross- Validation</u>
Individual ratings of safety	-.11**	-.06	-.06	-.07*
Area characteristic (mean division rating)	-.13**	-.12**	-.10**	-.06
Delineated situation component	-.20**	-.20**	-.12**	-.12**
Physical environment	-.13**	-.16**	-.10**	-.06
Work and social environment	-.16**	-.18**	-.06**	-.09**
Personnel resources	-.19**	-.15**	-.12**	-.12**
Residual situation component	.00	.01	-.02	.02
Individual uniqueness	-.06	.00	-.02	-.04
Delineated individual differences	-.05	-.04	-.06	-.06
Residual individual differences	-.05	.00	-.01	-.04
N	1,147	1,158	1,147	1,158

* p < .05

** p < .01

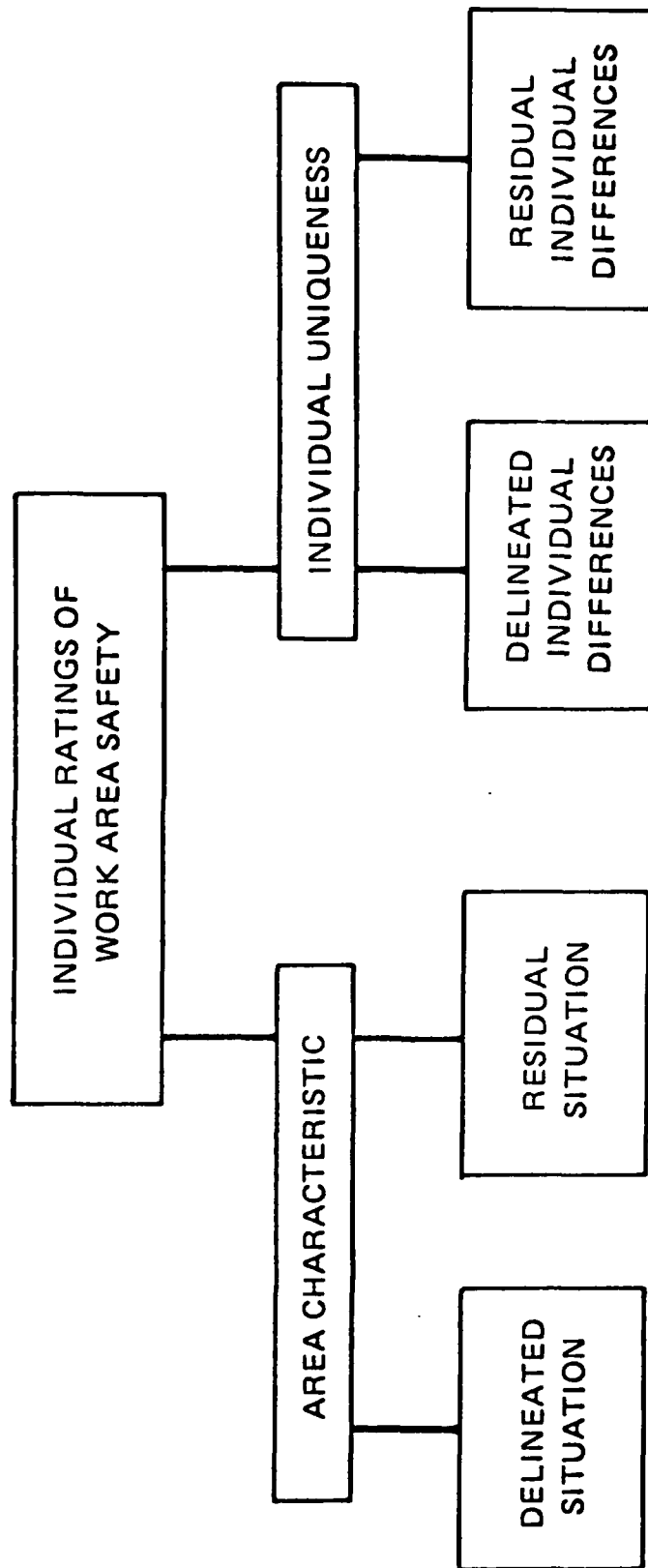


Figure 1. Components of the Perception of Safety

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